MCGINN & GIBB, PLLC
A PROFESSIONAL LIMITED LIABILITY COMPANY
PATENTS, TRADEMARKS, COPYRIGHTS, AND INTELLECTUAL PROPERTY LAW
8321 OLD COURTHOUSE ROAD, SUITE 200
VIENNA, VIRGINIA 22182-3817
TELEPHONE (703) 761-4100
FACSIMILE (703) 761-2375; (703) 761-2376

APPLICATION FOR UNITED STATES LETTERS PATENT

APPLICANT'S: HIROYUKI NOGUCHI, ET AL.

FOR: METHOD OF CASTING ALUMINUM OR ALUMINUM ALLOY

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TITLE OF THE INVENTION

METHOD OF CASTING ALUMINUM OR ALUMINUM ALLOY

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a method of casting aluminum or aluminum alloy to produce castings such as automobile aluminum wheels or the like.

DESCRIPTION OF THE RELATED ART

Aluminum or aluminum alloy castings such as aluminum wheels have been conventionally manufactured by casting methods using a metal mold, for example by the metal mold casting technique. For casting iron, on the other hand, casting methods employing a mold formed from green sand (sand mold) are also employed. This is because, when casting iron, slow cooling will not impose any problem in terms of the casting quality, and also because metal molds are difficult to use for casing iron due to its high melting temperature.

In addition to these prior arts, a casting method has been proposed that employs a green sand mold while taking its cooling speed into account (see Japanese Patent Laid-Open Publication No. 2002-307158). This patent publication discloses a cooling method which is intended to minimize the usage of circulated molding sand and also to enable the control of cooling time for each type of castings, and which comprises the steps of injecting molten metal into a green sand mold, primarily cooling the casting down to a

temperature lower than the solidus temperature, then collapsing a part of the green sand mold that has not been thermally affected to separate and remove the same, and secondarily cooling the casting that is surrounded by the remaining sand that has been thermally affected for a period of time determined according to properties of the casting. It should be noted that in this patent publication materials of castings are not considered.

Conventionally, no method has been practiced that is capable of casting aluminum or aluminum alloy using a mold made from green sand, and the above-mentioned patent publication does not disclose such method either. For casting aluminum or aluminum alloy, cooling speed should be sufficiently high near the solidus line. Otherwise, fine cast structure cannot be obtained and the quality of castings thus produced will be poor. For this reason, conventional methods of casting aluminum or aluminum alloy employ a metal mold in order to ensure the requisite cooling speed.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a method of casting aluminum or aluminum alloy which enables molten aluminum or aluminum alloy to be cast in a sand mold made from green sand, and thereby to realize remarkable improvement in productivity.

A method of casting aluminum or aluminum alloy according to the present invention comprises the steps of

producing a sand mold; injecting molten aluminum or aluminum alloy into the sand mold; cooling a casting thus obtained together with the sand mold by means of water or liquid coolant; and dismantling the sand mold.

In this method of casting aluminum or aluminum alloy, the step of cooling by means of water or a liquid coolant comprises dipping the sand mold together with the casting in water.

A method of casting aluminum or aluminum alloy according to another aspect of the present invention comprises the steps of producing a unit sand mold within a mold making chamber on a casting line, the unit sand mold having cavities on the front and rear faces thereof in the direction of the casting line; connecting a plurality of unit sand molds thus produced on the casting line by joining the front face of one unit sand mold to the rear face of the preceding unit sand mold to form a train of connected sand molds, and injecting molten aluminum or aluminum alloy into the cavity through an injection port provided at the boundary between the joined faces; dividing the train of connected sand molds by cutting at a substantially central portion of each unit sand mold or of every nth sand mold (n is an integer of at least 2), and dipping the unit sand mold(s) into water or liquid coolant; and dismantling the sand mold.

In a preferred embodiment, the method of casting aluminum or aluminum alloy according to the present invention may comprise the step of drying sand obtained by

dismantling the sand mold and supplying this sand to the casting chamber for reuse.

According to the method of the present invention, molten aluminum or aluminum alloy is injected in a sand mold and then cooled together with the sand mold for example by dipping in water or liquid coolant for quenching the casting. As a result, the aluminum or aluminum alloy casting thus obtained has a fine structure and hence high strength equivalent to those that would be obtained by the metal mold casting technique. The speed of this casting method using sand molds is determined by the step of making sand molds. Since sand molds can be produced in a relatively short period of time and it is also possible to produce sand molds in a plurality of lines, sand molds can be supplied successively in a sufficiently high speed. In case of using a metal mold casting method, on the contrary, a series of steps of injecting molten metal, cooling, and opening the mold are performed sequentially in a single casting machine and therefore a next casting step can be started only after the completion of one casting. This fact makes the productivity of the metal molding technique extremely low. The productivity can be improved remarkably by using sand molds as implemented in the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a process chart illustrating the steps of a method of casting aluminum or aluminum alloy according to an embodiment of the present invention;

Fig. 2 is a vertical cross sectional view showing the step of making sand molds;

Fig. 3 is a schematic perspective view showing the step of injecting molten metal;

Fig. 4 is a schematic view showing the cooling step; and

Fig. 5 is a schematic perspective view showing the step of dismantling sand molds.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will be described more specifically with reference to the drawings, in which Fig. 1 is a process chart illustrating the steps of a method of casting aluminum or aluminum alloy according to an embodiment of the present invention, Fig. 2 is a vertical cross section showing the step of making molds, Fig. 3 is a schematic perspective view showing the step of injecting molten metal, Fig. 4 is a schematic view showing the cooling step, and Fig. 5 is a schematic perspective view showing the step of dismantling sand molds. As seen from Figs. 2 and 3, the step of making molds and the step of injecting molten metal are performed on the same production line. Specifically, a mold is produced using green sand within a mold making chamber 1 (hereinafter referred to as "sand mold"). On one side of this mold making chamber 1, a die 2, which is provided with a casting shape portion 3 having a shape correspond to a half of a cast article to be produced, is rotatably supported on a horizontal rotating shaft 4

provided above the chamber 1. On the other side of the mold making chamber 1, another die 6, which is also provided with another casting shaping portion 5 having the shape corresponding to another half of the cast article to be produced, is fixed to a piston 7 of a hydraulic cylinder. Forward movement of the piston 7 causes the die 6 to compress, in cooperation with the die 2, sand located therebetween and thereby making a sand mold. It should be noted that the sand fed from the top of the mold making chamber 1 is recycled sand that has been treated as described below.

After a sand mold has been made, the die 2 is swung up about the rotating shaft 4, the sand mold 10 thus produced (hereinafter also referred to as "unit sand mold") is pushed by the piston 7 driven by the hydraulic cylinder and expelled onto an upstream conveyor (PMC: Precision Mold Conveyor (trade name)) 11. The conveyor 11 extends in the direction where the dies 2 and 6 face each other, so that the sand mold 10 produced in the mold making chamber 1 is pushed by the piston 7, transferred onto the conveyor 11, and directly moved away from the chamber 1 by the conveyor 11.

An insert 12 is fitted in each of the recesses formed on the front and rear faces of the unit sand mold 10. Further, this unit sand mold 10 is connected, at the front face thereof, to the rear face of the preceding unit sand mold 10 on the conveyor 11, and thus a train of connected unit sand molds 18 is formed. A cavity 14 defining a

casting space is formed at the boundary where each pair of unit sand molds 10 is coupled. An injecting port 13 for injecting molten metal is formed at the bottom of the cavity 14 when coupling the unit sand molds.

As shown in Fig. 3, molten metal 22 (aluminum or aluminum alloy) which has been melted in a melting furnace 20 is supplied to a pressure injecting machine 21. The molten metal 22 is then supplied under pressure to the injecting port 13 at the boundary between the unit sand molds 10 via a gate 22.

The train of connected sand molds 18 is then cut off by a sand mold cutter 17 at every nth unit sand mold 10 (n is three in the illustrated example). More particularly, in the illustrated example, one of the connected unit sand molds 10 is cut off vertically to the connecting direction at a substantially central portion thereof. The following two unit sand molds 10 are left uncut, and the third one is cut off similarly at a substantially central portion thereof. In this manner, the train of connected sand molds 18 formed by connecting the unit sand molds fed out of the mold making chamber 1 is divided into blocks of connected sand molds 18 each having a length corresponding to that of three unit sand molds. These blocks of connected sand molds are then transferred from the mold making and injecting line (conveyor 11) onto a mesh conveyor 23 of a cooling line.

Subsequently, as shown in Fig. 4, a block of connected sand molds 18 is lowered and dipped into cooling water 31 in a water tank 30 by means of a lifter to be cooled in the

water. Preferably, the temperature of molten aluminum or aluminum alloy in the cavity of the sand mold prior to the water cooling is immediately above the solidus temperature, and such temperature is decreased down to near the normal temperature by rapidly cooling with water. The block of connected sand molds 18 is then taken out of the water by means of the lifter and fed to the next step of dismantling sand molds.

In the step of dismantling sand molds, the unit sand molds 10 are individually supplied onto a vibrating feeder 40 and are dismantled by the vibrating feeder 40 vibrated by an eccentric cam 41. At the same time as the sand molds are collapsed, castings 33 are collected on the vibrating feeder 40.

Loose sand from the sand mold collapsed by the vibrating feeder 40 falls down onto a sand receiver 42 and thermally dried on this sand receiver 42 by a burner 43. The sand is then cooled in a cooling tank, transferred to a belt conveyor 45 and supplied to the mold making chamber 1 as shown in Fig. 2 to be reused. In this manner, the sand used for making molds is recycled.

The casting 33 thus obtained is polished on the surface by shot blasting and finished as a final product such as an automobile aluminum wheel or the like.

According to the present embodiment as described above, molten aluminum or aluminum alloy is cast in a sand mold made from green sand (unit sand mold 10) and then quickly cooled down from temperature immediately above the solidus

temperature by being dipped in water together with the sand mold. Therefore, it is possible to achieve a cast structure that is as fine as a structure obtained by a metal mold casting method and to produce a high quality casting. Additionally, according to the present embodiment, the line speed is determined according to the speed of making sand molds. Since a time period required for making one unit sand mold 10 is short and, further, sand molds can be made in a plurality of lines, the number of castings produced per unit time is large, achieving high productivity. In other words, the method according to present invention improves the productivity considerably in comparison with the metal mold casting technique conventionally used for casting aluminum or aluminum alloy, according to which a series of processes, including injecting molten metal, waiting for cooling down, opening molds to take out a casting, assembling the molds again, and injecting new molten metal, are required to be completed before starting a next casting process.

It should be noted that the present invention is not limited to the embodiment as described above, but other modifications are possible. For example, the cooling may be accomplished by spraying cooling water instead of dipping in water. It is also possible to dip in liquid coolant instead of water. In either case, the speed of cooling castings can be increased remarkably in comparison with conventional sand mold casting techniques. Further, the unit sand molds as shown in Fig. 2 are each provided with cavities

corresponding to halves of an article to be cast on the front and rear faces thereof, so that one casting is produced from a combination of the front cavity of one unit sand mold and the rear cavity of the preceding unit sand mold. However, the present invention is not limited to such constitution, and it is also possible to form a plurality of half cavities on the front and rear faces in the direction where unit sand molds are connected, so that a plurality of castings are produced from a combination of the half cavities on the front face of one unit sand mold and those on the rear face of the preceding unit sand mold.